APPENDIX II. EXAMPLE AUDIT AND DIAGNOSTIC PROCESS

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Overview

This appendix provides a flow chart to illustrate a possible sequence for carrying out tasks in the initial audit and diagnostic phase of a whole-house residential commissioning process. Supporting text in a table summarizes the commissioning tasks by describing what each task does, what test protocols could be used, what equipment is needed, how long each task takes, and the potential energy savings associated with carrying out each task. More details about the commissioning process and these tasks are described in Appendix I "Guidelines for Residential Commissioning". Appendix III provides a sample commissioning report that could be used to document the audit and diagnostic findings from commissioning a house using the sequence of tasks described here. The data included in the report are for an actual house in Concord, California, which has been retrofitted recently as part of a U.S. Department of Energy (DOE) demonstration of residential commissioning.

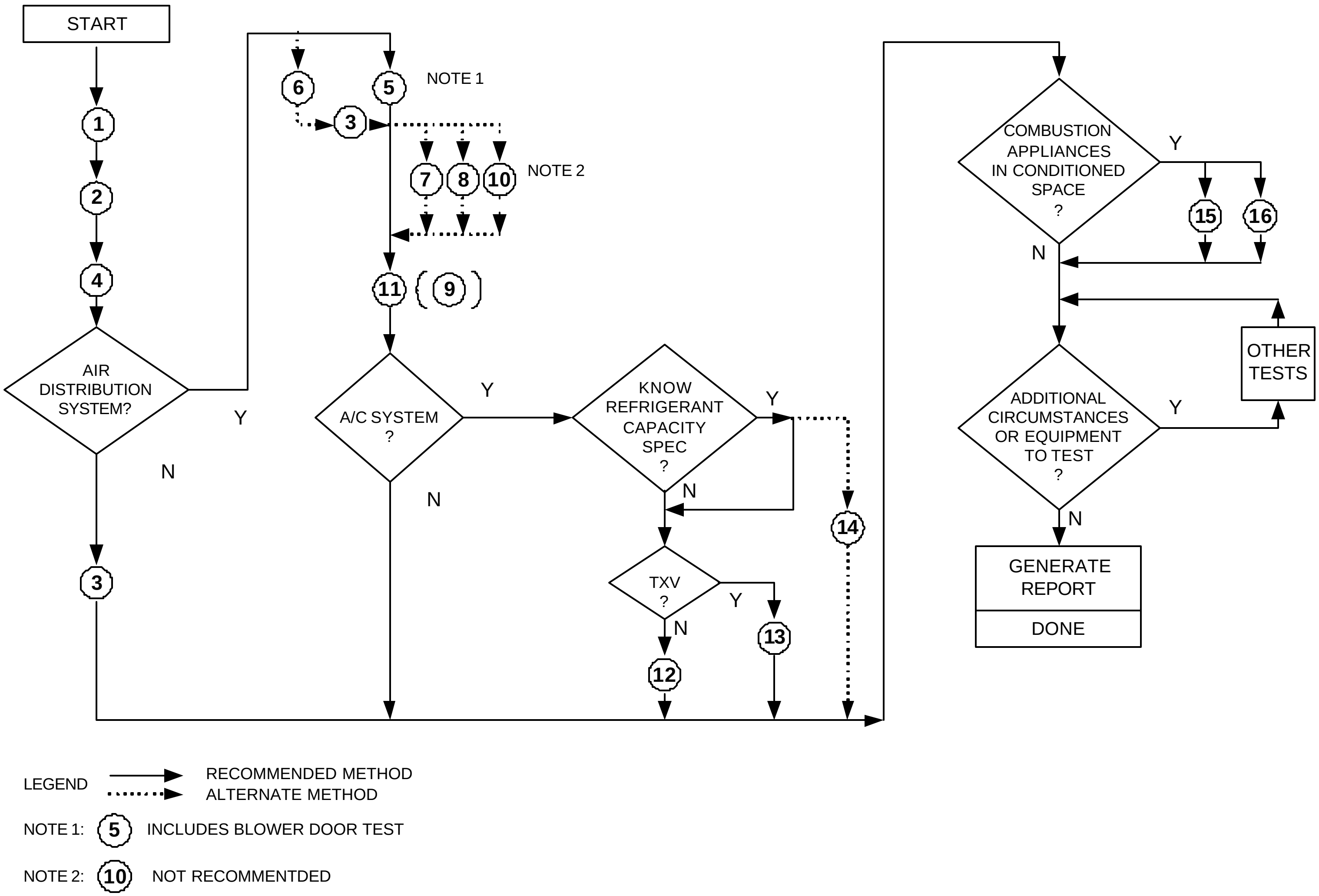
In general, we do not recommend that potential energy savings from commissioning be assessed on a component-by-component or task basis. Instead, the package of proposed retrofits should be addressed as a system because of the significant interactions between components. Component estimates are difficult to estimate individually, because they are highly dependent on the type of house and equipment that is being commissioned, on the quality of the construction and installations, and on the order in which retrofits are applied (returns from improvements diminish as retrofits are incrementally applied). Not withstanding these caveats and difficulties, it is still somewhat useful to roughly disaggregate the categorical energy savings for the various commissioning tasks to understand their relative generic importance. Consequently, we have listed potential savings as high (e.g., for duct sealing) when we believe that there is a potential for more than 10% savings through component improvements; medium corresponds to potential savings less than this. A low category is not used (which could be taken to mean little or no potential energy savings). For cases where such a category could be used (e.g., combustion spillage tests), there are overriding health and safety issues that take precedence, and we have noted them as such.

It is important to recognize that diagnostics involving airflow and pressure measurements must be carried out one at a time. To estimate the time required to carry out multiple tests of this type, one needs to add the individual times listed. In some cases, there may be some minor time reductions associated with having equipment already setup (e.g., 5 to 10 minutes). An example is measuring envelope airtightness with a blower door and then duct leakage only to outside using the duct pressurization test, which requires the use of the blower door as well. One exception is the DeltaQ test, which simultaneously measures envelope airtightness and duct leakage. Other diagnostics such as insulation inspection or window characterization can be carried out while these types of tests are underway, as long as envelope airtightness remains undisturbed during the test.

Also, in many cases, the equipment from one diagnostic can be used for other diagnostics, often with only slight modifications. An example is the envelope airtightness test and DeltaQ duct leakage test, where both tests use the same equipment (the DeltaQ test uses a blower door and a pressure measurement device to simultaneously determine envelope airtightness and duct leakage). Another example is using the fan-assisted flow meter to determine air-handler airflow and the fan-assisted flow hood to determine duct airflows. Both devices use a fan-assisted flow meter; the latter also has a flow capture hood.

We have included the temperature split method of assessing air-handler airflow in the flow chart for completeness because it is currently described in California Title 24. However, we do not recommend its use, because it is prone to errors of more than 20% in many cases and nearly a factor of two in worst cases, due to flow nonuniformities and radiant effects (Palmiter and Francisco 2000). It is particularly problematic when used to assess airflows in systems that have inadequate refrigerant charge, because of the wide variation in air temperatures downstream of the evaporator coil (Wray et al. 2002).

EXAMPLE AUDIT AND DIAGNOSTIC TASK SEQUENCE



Recommended Audit and Diagnostic Procedures

Task	Name	Description	Protocol	Equipment	Time (min.)	Energy Savings Potential
1	Insulation Inspection	Check that the wall, attic, and floor insulation installation is in accordance with specifications.	ConSol 1999, "CIEE Final Project Report: Protocols for Energy Efficient Residential Building Envelopes"	Toolbox, infrared camera.	30-60	Medium
2	Window Inspection	Check that the window type (emittance and glazing gap) is in accordance with specifications.	No standards. Use equipment manufacturer's instructions.	Handheld window inspection tools.	30	Medium
3	Envelope Airtightness Test and Leak Detection	Determine the air tightness of the building envelope and determine the location of leaks.	ASTM E779-99, E1827-96, and E1186-87.	Blower door or equivalent and smoke stick.	30-60	Medium
4	Envelope Moisture Test	Check that construction details will not lead to moisture problems later on. The inspector must be knowledgeable about common moisture problems in the region.	No general standards exist. Available resources include EIFS inspection protocols from North Carolina and Georgia (NHCID 1998 and GAHI 2000), plus construction guidelines by Lstiburek and Carmody (1994) and RDH Building Engineering (2000).	Surface scanning dielectric meter and conductance probe.	30-60	Health and Safety
5	DeltaQ Duct Leakage Test	Determine the building envelope leakage and duct leakage (at operating conditions) using a combined test.	Walker et al. 2001.	Blower door or equivalent.	30	High
6	Duct Pressurization	Determine the duct leakage at a given pressure across the ducts.	ASTM E1554-94	Fan-assisted flow meter.	30	High
7	Air-Handler Airflow: Fan-Assisted Flow Meter	Determine the airflow across the air handler by redirecting all of the flow through a calibrated flow meter.	No standards. See CEE (2000) Section 3.13.1.	Fan-assisted flow meter.	30	Medium
8	Air-Handler Airflow: Plate and Grid	Determine the airflow across the air handler by inserting a calibrated flow plate into the filter slot.	Manufacturer's instructions.	Calibrated flow plate.	30	Medium

Task	Name	Description	Protocol	Equipment	Time (min.)	Energy Savings Potential
9	Air-Handler Airflow: Sum-of-Registers	Determine the airflow across the air-handler by adding up the duct leakage plus the flow through the grilles. This can be done on either the supply or return side of the system.	No standards. See CEE (2000) Section 3.13.3.	Fan-assisted flow hood (needs a duct leakage test also).	60	Medium
10*	Air-Handler Airflow: Temperature Split	Assess the airflow across the air-handler by measuring upstream and downstream air temperatures. Does not measure airflow.	No standards. See CEE (2000) Section 3.13.2.	Temperature sensors.	30	Medium
11	Supply Register Airflows	Determine whether the airflow into each room is in accordance with specifications.	No standards. Use equipment manufacturer's instructions.	Fan assisted flow hood.	60	Medium
12	Superheat Refrigerant Charge Test	Assess the refrigerant charge level for fixed-orifice-controlled cooling equipment.	No standards. See CEE (2000) Section 3.14.1.	Refrigerant gauge set, temperature sensors.	60	High
13	Subcooling Refrigerant Charge Test	Assess the refrigerant charge level for TXV-controlled cooling equipment.	No standards. See CEE (2000) Section 3.14.2.	Refrigerant gauge set, temperature sensors.	60	High
14	Gravimetric Test	Determine the amount of refrigerant charge present in the cooling equipment.	No standards. See CEE (2000) Section 3.14.4.	Refrigerant recovery equipment, vacuum gauge, vacuum pump, charging scale.	120	High
15	House Pressurization Spillage Test	Assess whether house depressurization caused by air moving appliances in a house could cause combustion appliance spillage, compared to generic norms.	NFPA 54-1999, ASTM Guide E1998-99, CAN/CGSB-51.71-95.	Digital pressure sensor.	30	Health and Safety
16	Cold Vent Establishment Spillage Test	Assess whether house depressurization caused by air moving appliances in a house could cause combustion appliance spillage, compared to house specific norms.	NFPA 54-1999, ASTM Guide E1998-99, CAN/CGSB-51.71-95.	Blower door or equivalent and digital pressure sensor.	180	Health and Safety

* This test is not recommended, but is included for completeness because it is currently described in California Title 24.

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